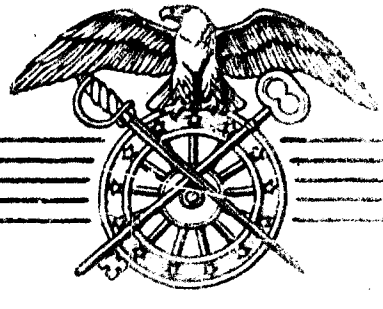
RESEARCH AND DEVELOPMENT REPORT

TEXTILE SERIES - REPORT NO. 71

AN EVALUATION OF ARMY SUMMER UNIFORM FABRICS

by
S. J. Kennedy, G. Winston, and C. J. Monego



DEPARTMENT OF THE ARMY

OFFICE OF THE QUARTERMASTER GENERAL

Office of The Quartermaster General
Research and Development Division
Textile, Clothing and Footwear Branch

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FOREWORD

The wearing of lighter weight uniforms during the summer by Army personnel has been authorized for many years. Traditionally, troops in posts, camps and stations go into summer uniforms by April or May, and continue wearing these uniforms until September or October, depending upon the section of the country. Officers purchase their own uniforms, which in recent years have been limited by regulations on summer uniforms to a tropical worsted fabric.

In 1949 a project was initiated to determine if some alternate fabrics should also be authorized for officers' and enlisted mens' optional summer uniforms. An opportunity was extended to the entire textile industry - wool, cotton, and synthetic - to submit samples of fabrics. After extensive solicitation of the industry, a total of 27 fabrics were submitted as being representative of the best available fabrics at that time for summer suitings of tropical weight. Of these fabrics, seven were selected by an advisory committee for the test, of which five actually were run in the test, one being rejected for unsatisfactory color and the other not being delivered by the mill. A substitute was chosen for this undelivered fabric. In addition, the standard 100 percent wool tropical worsted was used for a control.

The plan of test included two locations, one hot and wet--Fort Lee, Virginia - and one hot and dry--Fort Bliss, Texas. The statistical technique of the balanced incomplete block design was used to estimate the relative suitability of the seven fabrics. The test plan, after being carefully worked out, was submitted to a group of experts on determining consumer reactions in tests--The Methods Advisory Group of the Administrative Committee on Ultimate Consumer Goods, American Society for Testing Materials. After thorough review by this panel, the test plan was further reviewed with personnel of the Statistical Laboratory of the Virginia Polytechnic Institute, Blacksbury, Virginia.

Under the test plan there were 21 nonduplicating combinations of two uniforms, and each combination of uniforms was worn by four test subjects. Consequently a total of 84 officers was used at each test site.

It is believed that in the care taken in planning and conducting the test, with the minimizing of possible factors of bias, this field study is without parallel in the testing of blends of textile fibers. Furthermore, it is felt that the techniques developed for dealing with subjective aspects of the test will be useful to future investigators.

Accordingly it is considered that the marked preference found for the 100 percent tropical worsted by the test subjects is to be accepted as the result of a fair test.

This does not mean that some other blend or some other combination of fibers or some other fabrics would not have scored differently in the test. However, an opportunity was given to all fiber producers and to the mills to submit any fibers or fabrics they chose for the trial.

Section III of the report is based upon an analysis of the test results obtained by the Quartermaster Board, Fort Lee, Virginia. A great deal of credit is due the personnel of the Quartermaster Board, especially to Colonel Norman P. Williams, then President of the Board; Major George W. Bacous, Chief of the Board's Survey Division; Mr. Elie Weeks, Clothing Technologist, and Mr. John Griswold, Statistician, who were responsible for the conduct of the test. Special mention should also be made of the work by Lt. Raymond Nielson who supervised the conduct of the test at Fort Bliss, Texas.

The National Research Council Advisory Committee on Textile Fibers and Fabrics to whom the project was referred and who initiated the solicitation of fabrics for the test and selected the ultimate fabrics for the trial was comprised of the following members:

Dr. G. Preston Hoff, Chairman	E. I. du Pont de Nemours and Co., Inc.
Mr. A. W. Anthony	J. P. Stevens and Company, Inc.
Mr. A. G. Ashcroft	Alexander Smith and Sons Carpet Company
Mr. Martin Castricum	United States Rubber Company
Mr. John Christison	Peerless Division, Burlington Mills
Mr. H. A. Dickert	Georgia School of Technology
Mr. George Groh	Cannon Mills
Mr. Otto C. Haufe	Turner Halsey Company, Inc.
Mr. M. Earl Heard	West Point Manufacturing Company
Mr. G. K. Lake	Pepperell Manufacturing Company
Mr. H. Wickliffe Rose	American Viscose Corporation
Mr. R. E. Semmler	The Duplan Corporation
Mr. George A. Smith	Burlington Mills Corporation
Mr. Collins Thompson, Jr.	E. I. du Pont de Nemours and Co., Inc.

The committee appointed two panels -- one to select the fabrics to be tested, and the other to determine the test methods to be used for screening of the fabrics submitted by industry. The members of these panels were as follows:

Fabrics Panel:

Mr. George Smith, Chairman	Burlington Mills
Mr. A. W. Anthony	J. P. Stevens and Co., Inc.
Mr. Herman A. Dickert	Georgia School of Technology
Mr. Otto J. Haufe	Turner Halsey Company
Mr. Everett Nutter	Goodall-Sanford, Inc.
Mr. Ames Stevens	Ames Worsted Company
Mr. Joseph Meierhans	J. P. Stevens and Co., Inc.
Mr. Arthur Besse	National Association of Wool Manufacturers

Test Methods Panel:

Mr. A. G. Ashcroft, Chairman	Alexander Smith, Inc.
Mr. O. P. Beckwith	Alexander Smith, Inc.
Mr. G. S. Buck, Jr.	National Cotton Council
Mr. John Christison	Peerless Division, Burlington Mills
Mr. M. E. Heard	West Point Manufacturing Co.
Mr. G. K. Lake	Pepperell Manufacturing Co.
Mr. H. F. Schiefer	National Bureau of Standards

In addition to these, there is a great number of individuals without whose cooperation and generous assistance a project of this scope could not have been carried out. While it is not possible to express appreciation to all of them individually, special acknowledgment is made of the work of Mr. S. J. Tanenhaus who contributed throughout the test to the administrative planning of the project. The work of Mr. Tanenhaus in connection with this and other field trials on textile, clothing and footwear items has been of immeasurable value.

The laboratory section of the report was prepared by Mr. C. J. Monego and the field testing section by Mr. G. Winston both of the Quartermaster Laboratories in Philadelphia. Acknowledgment is due to Mr. John Davies who supervised some of the initial studies and planning in connection with this investigation and to Mr. L. I. Weiner, Head of the Quartermaster Textile Materials Engineering Laboratory where the laboratory analyses were conducted. The editorial assistance of Mr. Norman E. Roberts is the organization and preparation of the report is also gratefully acknowledged.

S. J. KENNEDY
Research Director
for
Textiles, Clothing and Footwear
Research and Development Division

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ABSTRACT

An evaluation of the suitability of seven fabrics for Army summer uniforms by means of statistically planned laboratory tests and actual wearing tests is described. The fabrics included the standard all-wool tropical worsted and six alternate constructions consisting of all-wool, all-synthetic, and blended fabrics. The laboratory tests were used to rank the fabrics on the basis of appearance, comfort, and wear. In the field test phase the fabrics were made into uniforms and worn by officers at Fort Lee, Virginia and Fort Bliss, Texas, and were evaluated on the basis of questionnaires administered to the test subjects, analysis of worn garments, and the opinion of a panel of judges. The test subjects evaluated the uniforms on the basis of which was the best buy (assuming price equality), which was acceptable per se, which gave the best appearance, most comfort, and best soil resistance. There was, in general, a good agreement between the laboratory and field test findings, which indicated that the all-wool standard was the most suitable fabric for a summer uniform. Appearance was found to be the most important single criterion for evaluating fabrics for this purpose, with comfort being only secondary in importance.

AN EVALUATION OF ARMY SUMMER UNIFORM FABRICS

This report describes an evaluation by the Quartermaster Corps of several alternate fabrics for officers and enlisted mens' optional summer uniforms. The standard fabric is a 100 percent wool tropical worsted. The alternate fabrics tested included both all wool, and a number of blended fiber fabrics, including wool-synthetic and all-synthetic blends. The methods employed and the conclusions reached should accordingly be of interest to a great many people interested in the testing of blended fabrics.

I. THE DEVELOPMENT OF CRITERIA FOR EVALUATION AND SELECTION OF THE TEST SAMPLES

At the initiation of this project it was evident that one of the most important aspects would be that of the criteria to be used in evaluation, both for the laboratory screening of fabrics and for the field trial. Also, it was considered that one of the more important by-products of the test might well be the relating of these two sets of criteria through proper planning of the field trial.

When the project was first referred to the National Research Council Advisory Committee on Fibers and Fabrics in June 1949, the committee was asked to review possible alternates for the standard tropical worsted fabrics for Army officers' summer uniforms, and to recommend a program by which alternate fabrics could be considered and then submitted to appropriate tests.

One of the first actions of the committee was to establish general qualities which it felt a suitable fabric for this purpose should possess. The following characteristics were agreed upon:

1. The garment must hold its shape. It must be crush resistant. It must not get baggy.

2. It must "breathe" and be comfortable.

3. It must resist soiling, and be easily cleanable. This requirement does not specify either washing or dry cleaning, but does indicate that the soil must be removable.

4. The fabric must wear well regardless of whether tensile strength is used as a criterion.

Subsequently it was agreed by the committee that "appearance" should be added to the list of considerations, so that the final listing of criteria was as follows:

1) Ability to hold shape

2) Comfort

3) Appearance

4) Soil Resistance

5) Ability to wear well

Two subcommittees were appointed. One was assigned the task of obtaining candidate fabrics for consideration and recommendation to the committee. The second was given the responsibility of determining appropriate test methods by which the fabrics submitted by industry could be screened with a view to the selection of a relatively small number of fabrics for the actual field trial.

The Test Methods Subcommittee on 24 October 1949 recommended a series of tests to be used for screening the fabrics submitted. These tests are listed in Table I together with the numbers by which they are designated in Federal Specification CCC-T-191b where the methods are described in detail. Table I also shows the criteria to which each of the tests was related. It will be noted that these criteria include only appearance, comfort, and wear resistance. Available laboratory test methods did not provide a basis for direct evaluation of "ability to hold shape" and "soil resistance," although it was anticipated that these criteria could be used in the field trial.

The Fabric Screening Subcommittee on 14 February 1950 reported that after extensive solicitation of fabrics from industry a total of 27 fabrics had been obtained as being representative of the best then available in the market. Upon the recommendation of the subcommittee the fabrics were divided into eight categories, namely: 1) 100% wool; 2) 100% rayon; 3) 50% viscose - 50% acetate; 4) wool-rayon blends; 5) a blend of mohair, viscose, nylon, and acetate; 6) wool-nylon blends; 7) 100% nylon; and 8) nylon-rayon blends.

TABLE III

LABORATORY TESTS RECOMMENDED BY THE NRC TEST METHODS SUBCOMMITTEE

Test Method*		Criteria		
Description	No.	Appearance	Comfort	Wear Resistance
Texture	5050	X	X	
Weight	5041		X	
Air permeability	5450		X	
Tensile strength (grab)	5100			X
Thickness**	5030		X	
Colorfastness		X		X
a. Fading	5660			
b. Perspiration	5680			
c. Dry Cleaning	5622			
Shrinkage after laundering and Dry Cleaning	5556 + 5580			X
Sewability	5110 + 5400	X		X
Crease recovery***	5212	X		
Tear resistance (tongue)	5134			X

* Federal Specification CCC-T-191b, 15 May 1951, Textile Test Methods.

** Measured under pressure of 0.1 lb. (1.6 oz.)/sq.in. This permitted better discrimination between the thickness of the fabrics in this series than the 10 oz./sq.in. pressure required by Method 5030.

*** Angle-of-Recovery Method: Used in place of the wrinkle resistance and crease acceptance and retention tests recommended by the NRC because the latter procedures, which were in the development stage when this directive was prepared, are still producing erratic results.

The 27 fabrics as submitted are shown in Table II, together with the data obtained on each from a number of the laboratory tests. Those fabrics which were ultimately selected for the field trial are identified by asterisks.*

In Table III is shown further detailed information on the seven fabrics selected for the field trial. It will be noted that one of the fabrics originally selected, the NRC Code No. 12 made of 100 percent viscose, was ultimately rejected because its shade was sufficiently different from the color of the other fabrics that it was felt its appearance ranking in the field trial might have been affected. The seventh fabric, the NRC Code No. 22 made of 100 percent wool, was never delivered by the mill and was accordingly replaced by another similar 100 percent wool fabric, also of different construction from the standard all-wool tropical. This fabric was identified by Quartermaster Corps Code B.

The standard fabric was used as a control (Quartermaster Corps Code H).

II. THE LABORATORY PHASE OF THE TEST

A. Objective of the Laboratory Tests

The primary objective of the laboratory phase of the test was to evaluate the physical properties of the experimental fabrics with a view to selecting those fabrics to be used in the field trial. It was hoped that the data from the combination of laboratory tests would provide a basis for predicting ultimate consumer characteristics, such as appearance, comfort, and wear under conditions of summer use. The physical properties as revealed by these tests were then analyzed so as to categorize into groups those fabrics which did not differ significantly from one another.

Table IV shows the data used in a preliminary ranking of the fabrics based upon the tests listed in Table I. The table gives the average tests values and the relative ranking of the fabrics for each of the characteristics listed under the three criteria of appearance, comfort, and wear.

After examination of the data in Table IV, it became evident that due to the wide variations in these fabrics some modification of the originally proposed test program would be desirable in order to obtain a more discriminating ranking according to each of the criteria.

* Any discrepancies noted between the data in Table II and the corresponding data in subsequent tables are due to the fact that the information in Table II was obtained from the samples initially submitted for consideration by the NRC Committee, whereas the other data were obtained from samples subsequently delivered for the full-scale program.

TABLE II

PHYSICAL CHARACTERISTICS OF FABRICS SUBMITTED TO THE NRC FABRIC SCREENING SUBCOMMITTEE

NRC No.	Weight (ozs per square yard)	Finished Texture		Nominal Fiber Composition (%)	Tensile Strength Grab (lbs)		Tear Resistance Tongue (lbs)		Shrinkage (%)*				Air Perm. (cu.ft./sq.ft./min.)	Wrinkle Indices**			
									Dry Cleaning		Laundering			Resistance	Recovery	Resistance	Recovery
		Ends	Picks		Warp	Filling	Warp	Filling	Warp	Filling	Warp	Filling		65% R.H.		90% R.H.	
Std.	6.8	53	47	100 wool	77	60	3.5	2.5	2.0	2.0	3.9	1.1	35				
2	6.3	52	43	100 wool	61	56	3.2	3.0	2.8	1.5	1.9	2.5	44.5	7.2	9.6	4.9	9.3
4***	6.0	53	55	100 wool	56	52	3.4	3.1	0.6	0.3	1.3	0.6	84.1	17.5	7.9	5.5	9.5
5	6.2	50	45	100 wool	50	45					4.0	3.0		8.3	9.2	5.2	8.9
22***	6.2	47	42	100 wool	67	53	3.6	3.2	2.5	2.8	5.1	9.5	90.9	25.0	5.0	4.2	9.4
23	6.2	47	43	100 wool	69	58	3.8	3.6	2.5	2.2	4.9	6.6	94.8	23.8	9.3	4.4	9.2
7	6.3	47	48	60 wool, 40 mohair	55	56	2.8	2.8	0.3	0.6	2.5	1.6	65.9	9.3	9.5	4.0	9.0
6	7.5	50	43	100 viscose	95	82	3.8	4.0	0.6	0.6	4.4	1.5		2.9	8.1	3.2	9.1
12***	6.7	58	53	100 viscose	88	80	3.5	3.5	2.0	negl.	3.1	-1.0	155	4.4	8.3	2.7	9.0
16	7.0	100	38	100 rayon										6.9	8.3	2.9	7.9
17	8.0	82	64	100 rayon										4.7	8.0	2.7	9.0
18	7.0	50	46	100 rayon										3.7	8.9	1.6	8.0
19	7.0	100	38	100 rayon										4.8	8.5	2.6	8.6
25	8.0	60	50	100 rayon	143	126	10	8.0	1.0	1.5	4.7	-2.5	57.0	8.7	6.3	2.4	9.5
27	6.4	74	47	100 rayon	110	68.8	5.0	4.0					98.0	4.5	8.0	2.3	9.4
9	6.9	66	45	50 acetate, 50 viscose	75	77	2.4	2.9	1.1	0.8	5.0	-0.4	69.0	8.1	9.4	3.9	9.4
10***	6.6	56	49	50 acetate, 50 viscose	82	69	4.1	4.3	0.4	0.8	3.2	2.1	83.0	5.5	8.9	5.5	8.7
11	7.4	54	47	20 wool, 80 viscose	100	90	6.5	5.8	1.0	negl.	2.6	1.0	82.8	5.4	9.1	3.8	9.0
13	7.3	57	46	24 wool, 76 rayon	86	60	5.0	3.6	negl.	2.0	1.1	-2.8	89.0	4.1	8.7	2.1	9.5
14***	5.6	60	46	21 wool, 79 rayon	81	49	5.0	4.1	negl.	1.7	1.4	-1.1	125	5.9	8.6	3.1	9.1
15	7.3	59	46	40 wool, 60 rayon	75	53	3.4	2.5	1.0	1.0	2.8	0.8	62.0	4.5	9.1	1.6	9.6
20	7.3	50	43	20 wool, 80 rayon										10.0	8.0	7.8	8.4
21	7.3	50	45	20 wool, 80 rayon										9.7	8.4	6.2	9.0
8***	6.8	48	42	29 mohair, 44 viscose 5 nylon, 22 acetate	100	73	4.9	4.3	negl.	negl.	0.3	0.0	60.0	6.2	8.6	2.8	8.9
1	6.1	51	45	80 wool, 20 nylon	120	113	7.8	6.0	negl.	negl.	<1.0	<1.0	49.0	16.1	8.7	5.8	8.6
3***	5.7	54	50	90 wool, 10 nylon	74	49	4.0	3.0	1.6	2.8	0.1	2.5	83.8	6.1	9.1	4.7	9.0
24	6.3	52	45	100 nylon	256	229	24	18	1.0	1.0	1.7	0.6	126	14.1	9.2	13.3	8.8
26	5.9	55	40	12 nylon, 88 rayon	121	101	12	11	-0.5	negl.	2.5	0.3	211	7.4	7.9	4.3	9.4

* - indicates elongation

** Determined on duPont Wrinkleometer

*** Fabrics recommended for immediate consideration by the Quartermaster Corps.

TABLE III

FIBER AND YARN DATA ON THE FABRIC SAMPLES

Code		Fiber Blends		Average Diameter, Microns*		Fiber Characteristics Specified in Procurement Directive		Yarn Ply	
NRC	QMC	Type	Percent	Nominal	Actual	Denier	Staple Length	Warp	Filling
10	A	Acetate	50	19.6	17.0	3	2	2	2
		Viscose	50	20.6	19.0	3	2		
-	B	Wool	100	23.3	24.2	U.S. Standard	62s	2	2
14	C	Wool	21	28.0	28.5	U.S. Standard	56s	2	2
		Viscose		14.5	14.0	1 1/2	2 1/2		
		Viscose	79**	20.6	21.0	3	2 1/2		
3	D	Wool	90	23.3	23.0	U.S. Standard	62s	1	1
		Nylon	10	19.8	18.5	3	3		
4	E	Wool	100	23.3	22.5	U.S. Standard	62s	2	1
8	F***	Warp:						2	-
		Dull Viscose	50	20.6	19.0	3	2 1/2		
		Chrome Spun Acetate	50	19.6	17.0	3	2 1/2		
		Filling:						-	1
		Mohair	65	37.0	30.0	Not lower than 24s			
		Bright Viscose	25	27.4	26.0	5 1/2	5 to 7		
		Semi Dull Nylon	10	19.8	18.5	3	4 1/2		
Std.	H	Wool	100	23.3	22.5	U.S. Standard	62s	2	2

Source of Data

1. Nominal Fiber Content and Staple length of fibers
   a. Purchase Control QMGKB 423 New York, 30 March 1950 NY-2-5048-00-0-07.
   b. Letter Covering fabrics D and F dated April 7, April 11 and April 15, 1952.
2. Nominal Fiber Diameters
   a. Textile Fiber Atlas, W. Von Bergen and W. Kraus, Textile Book Publisher's Inc. New York, 1949

* The objective was to obtain an adequate check on the diameters of the fiber blends as listed in the procurement directive. Only 25 fibers were used to measure the actual average diameter since its average agreed well with the nominal fiber diameters.

** I.e., a mixture of two viscose fibers of the specified characteristics in unknown proportions to equal 79% of the total fabric blend.

*** This will be referred to throughout the report as a blend of 29% Mohair - 44% Viscose - 22% Acetate - 5% Nylon. This is based on the fiber content of the overall fabric (not divided into warp and filling). This fabric was difficult t analyse in the laberatory for fiber content because it included 4 distinct fiber types. The most detailed analysis was made by the N.R.C. and indicated the fiber content to be as shown in this table. This analysis was in agreement with the procurement directive.

B. Analysis of the Significance of the Laboratory Tests

The following conclusions were accordingly reached concerning the recommended tests, based on the preliminary study of the data shown in Table IV.

Texture. The Test Methods Subcommittee had recommended that texture be considered as an appearance and as a comfort factor. It was considered that a closely woven fabric presents a better appearance than a loosely woven one. Conversely, from a comfort standpoint, under conditions of summer use, a loosely woven material is preferable. In the case of these fabrics, however, texture was not regarded as a valid measure of firmness of weave because there were wide differences in the size of yarns used in their manufacture. Some of the higher-textured fabrics such as Fabric C (21% wool - 79% rayon), which were woven with thin yarns, were actually looser as indicated by higher air permeability values than the lower-textured fabrics made of heavier yarns.

Because of these differences in yarn sizes, it was decided that cover index* should be used as a measure of firmness of weave which takes into account yarn size as well as texture.

From the standpoint of comfort, an excellent correlation was found between cover index and air permeability as measures of the looseness of weave. Therefore air permeability was considered sufficient as an indication of this aspect of comfort, and cover index was included as an appearance factor only.

Weight. The Test Methods Subcommittee had also recommended that weight be considered as a comfort factor inasmuch as lighter materials are considered to be more comfortable under conditions of summer use. Experience has shown, however, that weight is also important from the standpoint of appearance as well as comfort. Along with weight, stiffness was also considered as a factor both in appearance and comfort. Stiffness is considered to be important from the standpoint of appearance in that stiffer fabrics may under some conditions be expected to show better resistance to wrinkling. On the other hand, the limper fabrics might be expected to provide somewhat more comfort.

Air Permeability. Air permeability is obviously important from the standpoint of comfort for summer wear since it can be considered as an indication of openness of weave, and hence of the coolness of fabric.

* Cover index = $\frac{\text{ends/in.} + \text{picks/in.}}{\sqrt{\text{yarn count (adj.)}}}$. For the blended fabrics an adjusted yarn count was computed based on a weighted average of the specific gravity of each component fiber. The cover indices for all the samples are shown in Table VI and their calculations in Appendix A.

TABLE IV

PRELIMINARY LABORATORY EVALUATION OF SUMMER UNIFORM FABRICS USING TESTS ORIGINALLY RECOMMENDED BY THE NRC TEST METHODS SUBCOMMITTEE

(The higher the rank* number, the better the fabric)

CRITERIA	FABRICS A		B		C		D		E		F		H	
	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank
APPEARANCE														
Texture (threads/in.)														
Warp	56	5.5	50	1.5	58	7	54	3.5	53	3.5	49	1.5	56	5.5
Filling	49	6	44	2	47	3.5	49	6	50	6	40	1	46	3.5
Crease Recovery (%)														
Warp	68	2	86	5	63	1	86	5	85	5	72	3	89	7
Filling	68	2	83	7	57	1	79	4	81	5.5	76	3	81	5.5
Color Fastness **	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4
Fabric Sewability	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4
COMFORT														
Texture (threads/in.)														
Warp	56	2.5	50	6.5	58	1	54	4.5	53	4.5	49	6.5	56	2.5
Filling	49	2	44	6	47	4.5	49	2	50	2	40	7	46	4.5
Weight (Oz. per lin. yd. - 56" width)	10.0	2.5	10.7	2.5	8.5	5.5	7.8	7	9.0	5.5	10.0	2.5	10.7	2.5
Thickness (In. at 0.1 lb./in^2 pressure)	.020	4	.023	4	.018	4	.018	4	.019	4	.019	4	.020	4
Air Permeability (Cu. ft./sq. ft./min.)	80	5	23	1.5	151	7	81	5	81	5	68	3	25	1.5
WEAR RESISTANCE														
Color Fastness **	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4
Fabric Sewability	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4
Tensile Strength - Grab (lbs)														
Warp	69	3	83	6	58	2	77	4	51	1	83	6	84	6
Filling	53	3.5	62	5.5	44	1.5	54	3.5	43	1.5	63	5.5	72	7
Shrinkage (%)														
After 10 Launderings														
Warp	13.0	1	10.5	2	3.0	6.5	7.4	4.5	4.0	6.5	7.5	4.5	9.0	3
Filling	5.3	2	7.0	1	1.5	6	3.5	3.5	3.8	3.5	-0.5	6	1.0	6
After 10 dry cleanings														
Warp	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4
Filling	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4	Satis.	4
Tear Resistance, Tongue (lbs.)														
Warp	3.5	2.5	3.0	2.5	5.0	5.5	3.5	2.5	2.5	2.5	8.0	7	4.5	5.5
Filling	4.0	5	3.0	2	4.6	5	3.0	2	2.0	2	6.0	7	4.5	5

* Fabrics ranked on basis of statistical significant difference.

** As evaluated by Fadeometer, after perspiration conditions, dry cleaning and wet laundering.

Tensile Strength. The importance of tensile strength from the standpoint of wear resistance has never been adequately established. It was, nevertheless, recommended by the NRC Test Methods Subcommittee that this test be included for ranking the fabrics, since it measures certain strength properties related to wear resistance which are not covered by any other tests. A more important test with respect to wear resistance, which was included, was the new flex abrasion test. Since this method, which was under development at the time of the NRC recommendations, has subsequently provided results correlating reasonably well with field test findings, it was added to the strength tests as a means of arriving at a final ranking of the fabrics for wear resistance.

Thickness, Colorfastness, Shrinkage, and Sewability. It was considered that thicker fabrics would have lower thermal conductivity than thinner fabrics; and therefore, thickness was included in the tests recommended by the NRC Committee as a comfort consideration. The test results in Table IV, show that the spread of thickness values was only 0.005 inch. Since this difference represents less than 0.1 BTU/sq ft/hr/deg F, the practical ranking for these fabrics may be considered to be equal.

Colorfastness was included in the NRC Committee recommendations as an appearance factor. It was recognized that the particular dyestuffs used on the samples could easily be modified if found to be unsatisfactory from a colorfastness standpoint. However, it was felt necessary to determine in preliminary tests whether the fabrics exhibited fading tendencies which would prejudice their final appearance rankings. Fortunately, the colorfastness results shown in Table IV indicated that all the fabrics were satisfactory and would be ranked equally from this standpoint.

The Test Methods Subcommittee recommended that shrinkage be considered as a wear factor because excessive shrinkage would limit the value of the fabrics, if not precisely from the standpoint of wear resistance, at least from the standpoint of fit. Shrinkage might also be an important appearance consideration. However, analysis of the results obtained reveals that the laundering shrinkage of all the samples, with one possible exception, was so high that none could be considered launderable. On the other hand, none of the fabrics shrank to an objectionable degree after dry cleaning.

The sewability of the fabrics was considered important from the standpoint of both appearance and wear resistance. By sewability is meant the amount of fabric yarn damage inflicted in the sewing operation. If this damage is excessive, the cut yarns may

spoil the appearance of conspicuous seams on the finished garment. From the standpoint of wear resistance, it is evident that if a high proportion of fabric yarns are cut, the strength of the seam will be greatly reduced. As in the case of colorfastness, it was found that the sewability of all these fabrics was satisfactory and they could be ranked equally.

The final laboratory rankings did not include the values obtained for thickness, colorfastness, shrinkage, or sewability, since all the fabrics were approximately the same in these respects. In any system of ranking, such as was used in this evaluation, in which a number of elements are averaged, the inclusion of any values that do not show significant differences among the samples only serves to mask the differences existing among the other characteristics.

Crease Recovery. The Test Methods Subcommittee originally recommended that the crease recovery of the samples be determined by two tests then under development, one to evaluate the wrinkle resistance of a sample and the other to show its crease acceptance and retension. However, because the two new tests were still producing erratic results when the final test program was implemented, it was decided to determine the crease recovery of the samples on a very simple commercial tester which measures the angle of recovery and is capable of giving consistent results.

Tear Resistance. The tongue tear test was suggested by the NRC Committee to supplement the tensile test to determine the strength of the samples as an indication of wear resistance. The only change in the NRC recommendations made in the final testing program with respect to tear resistance was that the impact pendulum tear test was used in place of the tongue tear test. It was felt that the impact test was more discriminatory than the tongue test and that it better simulated the type of tear encountered in service.

Final Laboratory Testing Program. As a result of the foregoing analysis, the final testing program, as outlined in Table V, was decided upon. It will be noted that this program differs from the original recommendations of the NRC Committee in the following particulars:

1. Texture was eliminated as an appearance and as a comfort factor; instead, cover index was considered, but only from the standpoint of appearance.

2. Stiffness and weight were included under appearance and comfort.

TABLE V

FINAL LABORATORY TESTING PROGRAM

Test Method*		Criteria		
Description	No.	Appearance	Comfort	Wear Resistance
Cover Index**	—	X		
Weight	5041	X	X	
Stiffness	5202	X	X	
Air permeability	5450		X	
Tensile strength (grab)	5100			X
Abrasion resistance (flex)	5300			X
Crease recovery***	5212	X		
Tear resistance (impact pendulum)	5132			X

* Federal Specification CCC-T-191b, 15 May 1951, Textile Test Methods.

** $\frac{\text{Ends/in.} + \text{picks/in.}}{\sqrt{\text{Avg. count (adj.)}}}$

*** Angle-of-Recovery Method. Used in place of the wrinkle resistance and crease acceptance and retention tests recommended by the NRC because the latter procedures, which were in the development stage when this directive was prepared, are still producing erratic results.

3. Flex abrasion resistance was added as a wear resistance factor.

4. The impact pendulum tear test was used for measuring tear resistance instead of the tongue tear test.

5. Tests for shrinkage, colorfastness, sewability, and thickness were not considered in the overall rank.

In accordance with the recommendations of the NRC Test Methods Subcommittee, these tests were run on the fabrics initially and also after ten mobile launderings and after ten dry cleanings. (The number of cycles was chosen arbitrarily since it was not specified by the Subcommittee). Only the data on the initial and dry cleaned samples were considered in ranking the fabrics. This was because of the above mentioned excessive shrinkage of virtually all the fabrics which makes it unrealistic to consider them launderable. As a point of interest, the effect of laundering on the various characteristics is shown in Table X (page 20). The dry cleanings were carried out by the method recommended by the National Institute of Cleaners and Dyers and described in Appendix B.

C. Results of the Laboratory Tests

After testing the fabrics in accordance with the revised program, the average data and rankings of the fabrics for appearance, comfort, and wear were obtained, as shown in Tables VI, VII, and VIII, respectively. The values are shown on the fabrics "as received" (initial) and after ten dry cleanings.

1. Appearance

Fabric H (Standard) - 100% Wool - Fabric H had the highest cover index of all the fabrics in the series, indicating a firm structure. It was ranked as one of the heaviest and stiffest fabrics and among the highest in crease recovery value. All these factors indicate that the fabric possessed good dimensional stability, i.e., it would not easily bag at the knees and elbows.

Fabric A - 50% Acetate and 50% Viscose - Although Fabric A had the same number of warp ends per inch as the standard fabric and a few more picks per inch, thinner yarns were used, resulting in a lower cover index. Therefore, the cloth structure was not

TABLE VI

LABORATORY EVALUATION OF THE APPEARANCE OF SUMMER UNIFORM FABRICS

(The higher the rank* number, the better the fabric)

CRITERIA	FABRICS													
	A		B		C		D		E		F		H	
	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank
CREASE RECOVERY (%)														
Warp - Initial	68	2.0	86	5.0	63	1.0	86	5.0	85	5.0	72	3.0	89	7.0
After 10 dry cleanings	64	3.0	79	6.0	56	1.0	82	6.0	80	6.0	61	2.0	75	4.0
Combined Rank		2.5		5.5		1.0		5.5		5.5		2.5		5.5
Filling - Initial	68	2.0	83	7.0	57	1.0	79	4.0	81	5.5	76	3.0	81	5.5
After 10 dry cleanings	59	2.0	79	6.0	56	1.0	79	6.0	81	6.0	76	3.5	73	3.5
Combined Rank		2.0		7.0		1.0		4.5		6.0		3.0		4.5
WEIGHT (oz./linear yd. 56" width)														
Initial	10.0	5.5	10.7	5.5	8.5	2.5	7.8	1.0	9.0	2.5	10.0	5.5	10.7	5.5
After 10 dry cleanings	10.0	5.5	10.9	5.5	8.8	2.5	7.7	1.0	9.1	2.5	10.4	5.5	10.7	5.5
Combined Rank		5.5		5.5		2.5		1.0		2.5		5.5		5.5
STIFFNESS (10^{-4} lbs.)														
Warp - Initial	13.2	5.0	16.4	7.0	11.6	2.0	10.8	2.0	13.2	5.0	11.2	2.0	14.0	5.0
After 10 dry cleanings	10.0	2.5	16.0	7.0	10.3	2.5	11.0	2.5	12.7	5.5	9.3	2.5	13.7	5.5
Combined Rank		4.0		7.0		2.0		2.0		5.5		2.0		5.5
Filling - Initial	9.4	4.0	12.4	6.0	7.2	1.0	8.4	2.0	9.6	4.0	17.8	7.0	10.2	4.0
After 10 dry cleanings	9.0	3.0	16.0	6.5	7.3	3.0	8.3	3.0	9.3	3.0	16.0	6.5	10.0	3.0
Combined Rank		4.0		6.0		1.5		1.5		4.0		7.0		4.0
COVER INDEX														
Initial	23.4	4.5	23.8	6.0	21.4	1.5	21.3	1.5	22.7	4.5	22.1	3.0	24.8	7.0
After 10 dry cleanings	23.4	4.5	23.8	6.0	21.4	1.5	21.3	1.5	22.8	4.5	22.4	3.0	24.8	7.0
Combined Rank		4.5		6.0		1.5		1.5		4.5		3.0		7.0
OVERALL RANK		3.5		7.0		1.0		2.0		5.5		3.5		5.5

* Fabrics ranked on basis of statistical significant difference.

TABLE VII

LABORATORY EVALUATION OF THE COMFORT OF SUMMER UNIFORM FABRICS

(The higher the rank* number, the better the fabric)

CRITERIA	FABRICS A		B		C		D		E		F		H	
	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank
WEIGHT (oz. per linear yd-56" width)														
Initial	10.0	2.5	10.7	2.5	8.5	5.5	7.8	7.0	9.0	5.5	10.0	2.5	10.7	2.5
After 10 dry cleanings	10.0	2.5	10.9	2.5	8.8	5.5	7.7	7.0	9.1	5.5	10.4	2.5	10.7	2.5
Combined Rank		2.5		2.5		5.5		7.0		5.5		2.5		2.5
AIR PERMEABILITY (Cu.ft/sq.ft/min)														
Initial	80.0	5.0	23.0	1.5	151	7.0	81.0	5.0	81.0	5.0	68.0	3.0	25.0	1.5
After 10 dry cleanings	82.0	4.0	26.0	1.5	148	7.0	76.0	4.0	105	6.0	75.0	4.0	23.0	1.5
Combined Rank		4.5		1.5		7.0		4.5		6.0		3.0		1.5
STIFFNESS (10^{-4} lbs)														
Warp														
Initial	13.2	3.0	16.4	1.0	11.6	6.0	10.8	6.0	13.2	3.0	11.2	6.0	14.0	3.0
After 10 dry cleanings	10.0	5.5	16.0	1.0	10.3	5.5	11.0	5.5	12.7	2.5	9.3	5.5	13.7	2.5
Combined Rank		4.0		1.0		6.0		6.0		2.5		6.0		2.5
Filling														
Initial	9.4	4.0	12.4	2.0	7.2	7.0	8.4	6.0	9.6	4.0	17.8	1.0	10.2	4.0
After 10 dry cleanings	9.0	5.0	16.0	1.5	7.3	5.0	8.3	5.0	9.3	5.0	16.0	1.5	10.0	5.0
Combined Rank		4.0		2.0		6.5		6.5		4.0		1.0		4.0
OVERALL RANK		3.5		1.0		6.5		6.5		5.0		3.5		2.0

* Fabrics ranked on basis of statistical significant difference.

TABLE VIII

LABORATORY EVALUATION OF THE WEAR RESISTANCE OF SUMMER UNIFORM FABRICS

(The higher the rank* number, the better the fabric)

CRITERIA	FABRICS A		B		C		D		E		F		H	
	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank
TENSILE STRENGTH - Grab (lbs.)														
Warp - Initial	69.0	3.0	83.0	6.0	58.0	2.0	77.0	4.0	51.0	1.0	83.0	6.0	84.0	6.0
After 10 dry cleanings	73.0	4.0	72.0	4.0	63.0	2.0	70.0	4.0	55.0	1.0	86.0	6.5	86.0	6.5
Combined Rank		3.5		5.0		2.0		3.5		1.0		6.5		6.5
Filling - Initial	53.0	3.5	62.0	5.5	44.0	1.5	54.0	3.5	43.0	1.5	63.0	5.5	72.0	7.0
After 10 dry cleanings	61.0	5.0	61.0	5.0	39.0	1.5	51.0	3.0	41.0	1.5	58.0	5.0	72.0	7.0
Combined Rank		4.0		5.5		1.5		3.0		1.5		5.5		7.0
TEAR RESISTANCE - Impact Pendulum (lbs.)														
Warp - Initial	4.0	2.0	4.8	3.5	5.2	5.5	5.1	5.5	3.3	1.0	6.1	7.0	4.8	3.5
After 10 dry cleanings	2.6	1.0	5.6	5.5	4.0	2.5	5.3	5.5	3.8	2.5	5.3	5.5	5.2	5.5
Combined Rank		1.5		4.0		4.0		6.5		1.5		6.5		4.0
Filling - Initial	3.3	3.0	4.0	5.5	3.8	5.5	3.3	3.0	2.8	1.0	5.3	7.0	3.2	3.0
After 10 dry cleanings	2.2	1.0	4.4	6.0	2.5	2.0	3.1	4.0	2.8	3.0	5.6	7.0	3.8	5.0
Combined Rank		1.5		6.0		4.0		4.0		1.5		7.0		4.0
ABRASION RESISTANCE - Flex (cycles)														
Dry-Warp - Initial	78.0	2.0	691	5.0	81.0	2.0	1045	7.0	473	5.0	163	2.0	595	5.0
After 10 dry cleanings	48.0	2.0	945	6.0	54.0	2.0	1493	7.0	207	4.0	71.0	2.0	751	5.0
Combined Rank		2.0		5.0		2.0		7.0		5.0		2.0		5.0
Wet-Warp - Initial	76.0	1.5	263	6.0	47.0	1.5	283	6.0	249	6.0	125	3.0	227	4.0
After 10 dry cleanings	65.0	2.5	319	6.0	32.0	2.5	208	5.0	114	2.5	97.0	2.5	522	7.0
Combined Rank		1.5		6.0		1.5		6.0		4.0		3.0		6.0
OVERALL RANK		2.0		5.5		2.0		5.5		2.0		5.5		5.5

* Fabrics ranked on basis of statistical significant difference.

as firm. The weight was approximately the same as Fabric H. The crease recovery value was appreciably lower than the standard. Thus it would be expected that the fabric would wrinkle more easily than Fabric H, would require more frequent pressing, would become progressively worse in appearance the longer the uniform was worn.

Fabric B - 100% Wool - Fabric B had six less ends per inch and the two less picks per inch than the standard fabric. However, coarser yarns were used giving the cloth a cover index nearly equal to that of the standard. The fabric was stiffer than Fabric H and had high weight and crease recovery values, indicating that it would maintain a good appearance under conditions of summer use.

Fabric C - 21% Wool, 79% Rayon - Although Fabric C had the highest thread count, its cover index was one of the lowest because the yarns used were the thinnest of the series. This indicates that compared to the standard, the fabric had a loose structure. Fabric C weighed approximately two ounces less than the standard, had the poorest crease recovery value of all the fabrics included in this study and also was one of the limpest fabrics. The fabric could thus be expected to have to be pressed more frequently than any of the others and should have a poor appearance.

Fabric D - 90% Wool, 10% Nylon - Being less than 8 ounces in weight, Fabric D was lighter than would normally be acceptable for a 10 oz tropical worsted fabric. Although it had almost the same thread count as the control, the yarns used were thinner. Its cover index was the lowest, indicating a relatively loose structure, about the same as that of Fabric C. The crease recovery of Fabric D was slightly less than that of the standard initially, but it was superior after dry cleaning. The low stiffness rank of the sample was not much improved, however, by dry cleaning. In view of the low weight and cover index of this fabric, and of the fact that singles yarn instead of plied yarn was used in its construction, garments made from it could be expected to have less dimensional stability, i.e., resistance to bagging at the knees and elbows, than garments made from the standard fabric.

Fabric E - 100% Wool - Fabric E had three less ends and four more picks per inch than the control. The yarns were thinner, and the cover index was the third highest of the series. The fabric was approximately 1.5 ounces lighter, and at least as good as the control in crease recovery. Taking cognizance of all tests, this fabric should equal the standard in appearance.

Fabric F - 29% Mohair, 44% Viscose, 22% Acetate and 5% Nylon - Fabric F had seven less ends and six less picks per inch but was approximately equal to the standard fabric in weight. The fabric had a fair crease recovery value and a lower cover index than the

standard. It was slightly more pliable in the warp direction but stiffer in the filling direction than Fabric H. The data indicate that Fabric F would not possess as good an appearance as the standard.

2. Comfort

Fabric H, the all-wool standard, possessed low air permeability and was among the stiffest and heaviest in the group. These factors indicate that it would not be as comfortable under conditions of summer use as some of the other fabrics.

Although Fabric A, the acetate-viscose fabric, was as stiff as the standard in the initial stage, it became considerably more pliable in the warp after dry cleaning. Its air permeability was at least three times as great as that of the standard, but its weight was about the same. Fabric A should be more comfortable than the standard under conditions of summer use.

Fabric B, 100% wool, was stiffer than Fabric H, and showed about the same low air permeability and high weight as the standard in the initial stage and after dry cleaning. Fabric B was rated the least comfortable of the series.

Fabric C, the wool-rayon fabric, was about 2 ounces lighter than the standard. It had the highest air permeability and was among the most pliable of the seven. This fabric should be one of the most comfortable of the series.

Fabric D, the wool-nylon fabric, was the lightest of the series, weighing about three ounces less than the standard. Since it was also more pliable and had much greater air permeability than the standard, it should be more comfortable under conditions of summer use. Dry cleaning in general increased the pliability of this sample.

Fabric E, 100% wool, was lighter and had a much higher air permeability value than the standard, but was just as stiff. It should be superior to the standard in comfort.

Fabric F, the mohair-viscose-acetate-nylon fabric, had about the same weight as the standard but its air permeability was greater. It was more pliable in the warp direction than Fabric H but stiffer in the filling direction. This fabric would probably provide more comfort than the standard in the summer.

3. Wear Resistance

The standard all-wool fabric (Fabric H) had the highest tensile strength of any of the samples, had relatively good abrasion resistance, and had fair tear resistance. All these factors indicate that the fabric would wear well.

Fabric A, the acetate-viscose fabric, was appreciably lower than Fabric H in abrasion resistance, and somewhat lower in tearing strength and tensile strength. Indications were that the fabric would have a shorter service life than the standard.

Fabric B, 100% wool, had approximately the same tearing strength and abrasion resistance as the standard, but slightly less tensile strength. It should last approximately as long as the standard.

Fabric C, the wool-rayon fabric was inferior to the standard fabric in all tests except tearing strength, and even here was poorer after dry cleaning. Thus this fabric should have a shorter service life than the standard.

Fabric D, the wool-nylon fabric, had a lower tensile strength than Fabric H, but approximately the same or a little better abrasion resistance. Its warp tearing strength is higher, but its filling tearing strength is lower, than the standard. Thus the service life of Fabric D should be at least equal to that of the standard fabric.

Fabric E, 100% wool, had the lowest tensile strength of any of this series of fabrics and, in fact, does not meet specification requirements. It also had one of the lowest tearing strength values, but was comparable to the standard in abrasion resistance. Fabric E should not have as long a service life as the standard Fabric H.

Fabric F, made of mohair, viscose, acetate, and nylon, should be approximately equal to the standard in wear resistance. While its abrasion resistance was lower than that of the standard, it had the highest tearing strength of all the fabrics tested. In tensile strength it was about equal to the standard in the warp and slightly lower in the filling.

4. Summary of Overall Rankings

The results of the laboratory evaluations are summarized in Table IX. This table is based on the "overall ranks" shown at the bottom of Tables VI, VII, and VIII for appearance, comfort, and wear, respectively, both initially and after dry cleaning. In Table IX each of these ranks is categorized into one of three groups low (L), medium (M), and top (T).

5. Effect of Laundering

The above rankings are based upon fabric properties as shown by laboratory tests, prior to laundering or dry cleaning. It has been stated before however that the excessive shrinkage of

TABLE IX

Overall Laboratory Rankings of Unworn Fabrics
(L = Low Group, M = Medium Group, T = Top Group)

CRITERIA	FABRICS						
	A	B	C	D	E	F	H
Appearance	M	T	L	L	M	M	T
Comfort	M	L	T	T	M	M	L
Wear	L	T	L	T	L	T	T

these fabrics made it impossible to consider them as launderable, and for that reason the values obtained after laundering were not included in ranking the fabrics for their overall suitability for tropical uniforms. However, the average values obtained for each test before and after ten launderings are shown in Table X so that the influence of laundering on each characteristic can be observed. The samples were given regular wool mobile launderings as outlined in Federal Specification CCC-T-191b, Textile Test Methods (Method No. 5556).

The shrinkages of all the samples except Fabric C were excessive. All the materials suffered a loss in crease recovery, the rayons in general being more affected in this respect than the wool samples. It can be assumed that the mechanical action involved in laundering changed the characteristics of the fabrics so as to impair their crease resistance.

The excessive shrinkage of the fabrics was reflected in increased weight and decreased air permeability. The stiffness of the fabrics containing a high percentage of wool increased generally, while the rayons became more pliable after laundering. Both the tensile and tear strength tests showed that the wool samples in general became stronger after laundering. The wool-nylon blend lost in tearing strength but not in tensile strength. The rayon samples showed a somewhat greater tensile strength but were seriously affected in tearing strength as a result of laundering.

TABLE X

LABORATORY TEST DATA ON SUMMER UNIFORM FABRICS BEFORE AND AFTER TEN LAUNDERINGS

CRITERIA	FABRICS													
	A		B		C		D		E		F		H	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
SHRINKAGE (%) *														
Warp	1.1	13.0	1.7	10.5	2.5	3.0	4.5	7.4	1.1	4.0	6.7	7.5	2.2	9.0
Filling	-0.6	5.3	0.6	7.0	-1.7	1.5	6.7	3.5	1.1	3.8	3.9	-0.5	1.1	1.0
GREASE RECOVERY (%)														
Warp	68	49	86	75	63	53	86	77	85	74	72	55	89	69
Filling	68	47	83	85	57	53	79	77	81	74	76	74	81	70
WEIGHT (Oz./lin yd.-56" width)	10.0	11.0	10.7	12.9	8.5	8.9	7.8	8.6	9.0	9.8	10.0	11.4	10.7	11.6
STIFFNESS (10^{-4} lbs.)														
Warp	13.2	8.0	16.4	20.0	11.6	9.3	10.8	11.7	13.2	13.0	11.2	8.0	14.0	17.3
Filling	9.4	7.3	12.4	19.0	7.2	6.7	8.4	9.7	9.6	8.7	17.8	17.3	10.2	15.3
COVER INDEX	23.4	25.2	23.8	26.3	21.4	21.5	21.3	23.2	22.7	23.9	22.1	22.9	24.8	25.8
AIR PERMEABILITY (Cu.Ft./Sq.Ft./Min.)	80.0	66.0	23.0	22.0	151.0	118.0	81.0	64.0	81.0	64.0	68.0	67.0	25.0	16.0
TENSILE STRENGTH-Grab (lbs.)														
Warp	69.0	68.0	83.0	76.0	58.0	62.0	77.0	71.0	51.0	53.0	83.0	80.0	84.0	90.0
Filling	53.0	62.0	62.0	72.0	44.0	44.0	54.0	63.0	43.0	46.0	63.0	68.0	72.0	84.0
TEAR RESISTANCE - Impact Pendulum (lbs)														
Warp	4.0	3.4	4.8	4.8	5.2	4.3	5.1	4.6	3.5	2.9	6.1	4.8	4.8	4.6
Filling	3.3	3.1	4.0	4.1	3.8	3.0	3.3	3.2	2.8	2.7	5.3	5.0	3.2	3.9
ABRASION RESISTANCE - Flex (cycles)														
Dry Warp	78.0	157.0	691.0	1104.0	81.0	68.0	1045.0	934.0	473.0	528.0	163.0	127.0	596.0	1140.0
Wet Warp	76.0	77.0	263.0	362.0	47.0	38.0	283.0	402.0	249.0	176.0	125.0	95.0	227.0	346.0

* "Before" values represent relaxation shrinkage.
(- indicates elongation)

D. Laboratory Evaluation of Worn Garments

As a check on the laboratory values obtained on the fabrics when new, an identical series of laboratory tests was performed on pieces of fabric cut from garments returned from the field wear tests. One uniform of each fabric was randomly selected from those returned from both Fort Lee and Fort Bliss during the field test phase of this program. The uniforms from Fort Lee had each been subjected to 10 wear and dry cleaning cycles, those from Fort Bliss to 14. In all cases the dry cleaning procedure had been that outlined in Appendix B.

Tables XIA and XIB show the average test values obtained on the worn samples and the consequent rankings for appearance and comfort (Table XIA) and for wear (Table XIB). The overall rankings obtained, divided into three groups — low (L), Medium (M), and top (T) — are shown in Table XII. For comparison, the rankings of the unworn laboratory samples "as received" (initial) and after dry cleaning, as computed from Tables VI, VII, and VIII, and divided into the same low, medium, and top groups, are also shown in Table XII.

A striking agreement will be noted in Table XII between the rankings of the fabrics subjected to dry cleaning alone and those subjected to both wear and dry cleaning. This illustrates that laboratory evaluations should preferably be made on fabrics after they are dry cleaned when it is desired to predict ultimate consumer characteristics.

One of the notable exceptions is Fabric A which moved to the low group for appearance after wear and dry cleaning, whereas it was in the medium category as a result of dry cleaning alone. The reason for this was that some more crease recovery was lost after wear plus dry cleaning than after dry cleaning alone and considerably more stiffness was lost.

In the case of Fabric D, (wool-nylon), the comfort ranking was dropped from the top to the medium group. It appears from Tables VII and XIA that the wearing of this sample increased its stiffness to a much greater extent than did dry cleaning alone.

Fabric H, the all-wool standard, was reduced from the top to the medium group because wear plus dry cleaning lowered the tensile and tearing strength and abrasion resistance, whereas this sample was unaffected or even improved in these characteristics as a result of dry cleaning alone.

TABLE XI A

LABORATORY EVALUATION OF APPEARANCE AND COMFORT OF SUMMER UNIFORM FABRICS WORN AT FORT LEE AND FORT BLISS .

(The higher the rank* number, the better the fabric)

CRITERIA	FABRICS A Avg.	A Rank	B Avg.	B Rank	C Avg.	C Rank	D Avg.	D Rank	E Avg.	E Rank	F Avg.	F Rank	H Avg.	H Rank
APPEARANCE														
Crease Recovery (%)														
Warp - Ft. Lee	64	2.0	81	6.0	64	2.0	82	6.0	81	6.0	63	2.0	76	4.0
Ft. Bliss	57	1.0	76	4.5	61	2.5	80	6.5	79	6.5	62	2.5	73	4.5
Combined Rank		1.0		5.0		2.5		6.5		6.5		2.5		4.0
Filling - Ft. Lee	63	1.5	81	6.0	63	1.5	81	6.0	81	6.0	76	3.5	76	3.5
Ft. Bliss	55	1.5	76	5.0	57	1.5	77	5.0	78	5.0	74	5.0	73	5.0
Combined Rank		1.5		6.0		1.5		6.0		6.0		3.5		3.5
Weight**(oz/linear yd-56" width)														
Ft. Lee	9.5	5.5	10.9	5.5	8.4	2.0	8.4	2.0	8.7	2.0	10.5	5.5	10.1	5.5
Ft. Bliss	10.9	5.5	11.0	5.5	8.5	2.0	8.3	2.0	8.7	2.0	10.9	5.5	10.6	5.5
Combined Rank		5.5		5.5		2.0		2.0		2.0		5.5		5.5
Stiffness (10^{-4} lbs)														
Warp - Ft. Lee	8.0	2.0	17.3	7.0	8.3	2.0	11.7	4.5	12.0	4.5	9.0	2.0	14.0	6.0
Ft. Bliss	8.0	1.0	17.7	7.0	11.0	4.0	10.7	4.0	13.3	4.0	10.3	4.0	12.7	4.0
Combined Rank		1.0		7.0		2.5		4.5		4.5		2.5		6.0
Filling - Ft. Lee	8.3	1.0	16.7	7.0	9.3	2.5	9.3	2.5	11.3	4.5	15.7	6.0	11.7	4.5
Ft. Bliss	8.7	3.0	13.7	6.0	8.0	3.0	9.0	3.0	9.0	3.0	17.3	7.0	7.7	3.0
Combined Rank		1.0		6.5		2.5		2.5		4.5		6.5		4.5
OVERALL RANK		1.5		7.0		1.5		4.5		4.5		4.5		4.5
COMFORT														
Weight**(oz/linear yd. 56" width)														
Ft. Lee	9.5	2.5	10.9	2.5	8.4	6.0	8.4	6.0	8.7	6.0	10.5	2.5	10.1	2.5
Ft. Bliss	10.9	2.5	11.0	2.5	8.5	6.0	8.3	6.0	8.7	6.0	10.9	2.5	10.6	2.5
Combined Rank		2.5		2.5		6.0		6.0		6.0		2.5		2.5
Air Permeability (cu. ft/sq.ft/min)														
Ft. Lee	73	4.0	24	1.0	116	7.0	80	6.0	70	4.0	74	4.0	29	2.0
Ft. Bliss	63	3.0	30	1.5	119	7.0	84	6.0	75	4.5	74	4.5	30	1.5
Combined Rank		3.0		1.0		7.0		6.0		4.5		4.5		2.0
Stiffness (10^{-4} lbs)														
Warp - Ft. Lee	8.0	6.0	17.3	1.0	8.3	6.0	11.7	3.5	12.0	3.5	9.0	6.0	14.0	2.0
Ft. Bliss	8.0	7.0	17.7	1.0	11.0	4.0	10.7	4.0	13.3	4.0	10.3	4.0	12.7	4.0
Combined Rank		7.0		1.0		5.5		3.5		3.5		5.5		2.0
Filling - Ft. Lee	8.3	7.0	16.7	1.0	9.3	5.5	9.3	5.5	11.3	3.5	15.7	2.0	11.7	3.5
Ft. Bliss	8.7	5.0	13.7	2.0	8.0	5.0	9.0	5.0	9.0	5.0	17.3	1.0	7.7	5.0
Combined Rank		7.0		1.5		5.5		5.5		3.5		1.5		3.5
OVERALL RANK		5.0		1.0		7.0		5.0		5.0		3.0		2.0

* Fabrics ranked on basis of statistical significant difference.

** Disparity between the weight of Fabric A at Ft. Lee and Ft. Bliss was due to the much larger shrinkage of the fabric at Fort Bliss.

TABLE XI B

LABORATORY EVALUATION OF WEAR RESISTANCE OF SUMMER UNIFORM FABRICS WORN AT FORT LEE AND FORT BLISS

(The higher the rank* number, the better the fabric)

CRITERIA	FABRICS													
	A		B		C		D		E		F		H	
	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank	Avg.	Rank
Tensile Strength-Grab (lb.)														
Warp - Ft. Lee	60	3.0	85	6.5	57	3.0	69	3.0	62	3.0	71	3.0	83	6.5
Ft. Bliss	65	3.5	79	6.0	40	1.0	71	3.5	56	2.0	81	6.0	84	6.0
Combined Rank		3.5		6.5		1.0		3.5		2.0		5.0		6.5
Filling - Ft. Lee	56	2.5	65	5.5	50	2.5	53	2.5	46	2.5	72	7.0	64	5.5
Ft. Bliss	59	3.5	66	6.0	36	1.5	52	3.5	43	1.5	72	6.0	67	6.0
Combined Rank		3.5		5.5		1.5		3.5		1.5		7.0		5.5
Tear Resistance-Impact Pendulum (lb)														
Warp - Ft. Lee	2.7	1.5	4.9	6.5	3.7	3.0	4.7	6.5	3.0	1.5	4.2	4.5	4.4	4.5
Ft. Bliss	2.9	1.0	4.6	4.5	4.8	4.5	4.7	4.5	3.3	2.0	5.3	7.0	4.6	4.5
Combined Rank		1.0		6.0		3.0		6.0		2.0		6.0		4.0
Filling - Ft. Lee	2.5	2.0	4.0	6.5	2.4	2.0	3.0	4.5	2.5	2.0	4.2	6.5	2.8	4.5
Ft. Bliss	2.6	2.5	3.8	5.0	4.4	6.0	3.0	2.5	2.7	2.5	5.2	7.0	3.1	2.5
Combined Rank		1.5		6.0		4.0		4.0		1.5		7.0		4.0
Abrasion Resistance-Flex (Cycle)														
Dry Warp - Ft. Lee	85	2.5	932	6.0	82	2.5	1704	7.0	149	2.5	98	2.5	466	5.0
Ft. Bliss	107	2.0	364	6.0	35	2.0	485	6.0	280	4.0	119	2.0	419	6.0
Combined Rank		2.0		6.0		2.0		7.0		4.0		2.0		5.0
Wet Warp - Ft. Lee	63	2.5	233	5.5	39	2.5	496	7.0	127	2.5	101	2.5	210	5.5
Ft. Bliss	66	2.0	199	6.0	29	2.0	215	6.0	136	4.0	96	2.0	195	6.0
Combined Rank		2.0		5.5		2.0		7.0		4.0		2.0		5.5
OVERALL RANK		2.0		7.0		2.0		5.0		2.0		5.0		5.0

* Fabrics ranked on basis of statistical significant difference.

TABLE XII

COMPARISON OF LABORATORY RATINGS OF SUMMER UNIFORM FABRICS
AS RECEIVED, AFTER DRY CLEANING AND AFTER BEING WORN

(L = Low Group, M = Medium Group, T = Top Group)

CRITERIA	FABRICS						
	A	B	C	D	E	F	H
APPEARANCE							
Initial	M	T	L	L	M	M	T
After 10 dry cleanings	M	T	L	M	M	M	M
After Wear Cycles*	L	T	L	M	M	M	M
COMFORT							
Initial	M	L	T	T	M	L	L
After 10 dry cleanings	M	L	T	T	M	M	L
After Wear Cycles*	M	L	T	M	M	M	L
WEAR RESISTANCE							
Initial	L	T	L	T	L	T	T
After 10 dry cleanings	L	T	L	M	L	M	T
After Wear Cycles*	L	T	L	M	L	M	M

* Evaluation of samples of trousers worn in Field Test.

E. Conclusions of the Laboratory Evaluations

Based on the combined laboratory rankings of the fabrics in their initial state and after ten dry cleanings and also on the results of the laundering tests, the following conclusions may be drawn:

1. In appearance, the 100% wool fabrics ranked highest with Fabric B the best, followed by Fabrics H and E. Fabrics D and C (wool-nylon and wool-rayon blends) were in the lowest appearance rank.

2. In comfort, the fabrics with the highest air permeability and lowest weight were most desirable. Thus Fabrics C and D (wool-rayon and wool-nylon) were rated highest for comfort, followed in order by Fabrics E (100% wool), A (acetate-viscose) and F (mohair-viscose-acetate-nylon) with the all-wool fabrics H and B as the least comfortable.

3. In wear resistance, the samples fell into two groups, with the wool-nylon (Fabric D), two of the all-wool (Fabrics B and H) and the mohair-viscose-acetate-nylon (Fabric F) being rated tops and the three remaining samples rated low. It is significant that one of the most wear-resistant samples was the lightest (Fabric D) and another was the heaviest (Fabric H) of the series.

4. Laboratory evaluations should preferably be made on fabrics of this type after they are dry cleaned when it is desired to predict ultimate consumer characteristics of appearance, comfort, and wear. (None of the fabrics can be considered launderable, with the possible exception of Fabric C (wool-rayon) because of their excessive shrinkage).

III. OBSERVATIONS ON THE FIELD TEST PHASE

A. General Considerations

The NRC Committee on Fibers and Fabrics had suggested that the materials submitted by industry should "be subjected to wearing tests followed by appearance tests and questionnaires to see how

the uniforms stood up under actual conditions." A plan was prepared which would take into account the following aspects of analysis of the test results:

1. Equal precision of all comparisons among all fabric types.

2. High validity in the preference evaluations of the fabrics by the test subjects.

3. Discrimination among the fabric types as to their suitability for a summer uniform while taking full cognizance of the differences in the reactions among the test subjects. Each officer was to express his relative preference on a three-tone intensity basis of (a) much better, (b) moderately better, and (c) slightly better.

4. A sufficient wear period to enable each test officer to arrive at a reliable decision with respect to each of the criteria to be evaluated.

5. Corroboration of the judgments of the individual officers by means of a panel of field grade officers who would evaluate the appearance of the fabrics at the end of the test using the statistical design established for the test subjects.

6. The minimum valid sample size to hold down costs while still insuring that the maximum amount of information would be obtained from the test.

In order to eliminate any possible bias, the preliminary plan was submitted to the Advisory Group of the Administrative Committee on Ultimate Consumer Goods, American Society for Testing Materials, for review and comment. A number of methodological modifications, chiefly psychological in nature, were suggested and adopted.

The National Institute of Cleaning and Dyeing, Silver Springs, Maryland, was requested to supply a commercial dry cleaning procedure suitable for the various fabrics undergoing evaluation. The recommended specifications were included in the test directive.

The test directive to conduct the field test was prepared by the Textile and Leather Research Division of the Quartermaster Research and Development Laboratories, Philadelphia Pa. The Quartermaster Board, Fort Lee, Va., conducted the actual field test following the experimental design and plan of the test directive.

B. Objective of the Field Test Phase

The primary objective of the field test phase was to conduct an actual serviceability test whereby uniforms made from the various fabrics would be worn under normal conditions by military personnel. It was planned that the method of final evaluation would be by means of a questionnaire to be answered by the wearers.

The test was also extended to include certain other supplementary investigations, such as an "on-the-rack" evaluation of new garments, an analysis of wear failures during the service test, and a final rating of the garments after the wear phase for appearance by a panel of non-participating field grade officers.

C. Plan of the Field Test Phase

Test Sites

So that the results could be generalized for a wide range of climatic conditions under which these uniforms would be worn, the two test sites of Fort Lee, Virginia, which is warm-humid, and Fort Bliss, Texas, which is hot-dry, were selected.

Issuance and Coding of the Garments

The garments were issued in accordance with the statistical technique of the balanced incomplete block design.

Seven fabric types were evaluated and for maximum discrimination and comparison only two dissimilar uniforms were issued to each test subject. Care was taken to assure proper fitting of all the uniforms. All the possible 21 combinations of two uniforms were used and four test subjects wore each of these combinations of two uniforms at each test site. Consequently, 84 test subjects were used at each site (Fort Lee and Fort Bliss) for a total of 168 officers. Since each fabric type was paired with six other types and there were four of each pair or combination, 24 uniforms of each type were used at each site. The following table illustrates the 21 fabric combinations which were worn by four test subjects:

Code	A	B	C	D	E	F	H
B	4						
C	4	4					
D	4	4	4				
E	4	4	4	4			
F	4	4	4	4	4		
H	4	4	4	4	4	4	

In order to avoid any collusion between test subjects, a carefully coded system to mask the identity of the fabric types was used. First a serially numbered list was prepared and then the numbers were reversed so that, for example, numbers 123 and 124 would become 321 and 421. Consequently, should two test subjects compare their numbers to determine whether their uniforms might be made of the same fabric they would find it difficult since the number following 321 would be 421. In addition to this system of numerical identification, the two uniforms issued to the same test subject were respectively marked with the letters X and Y. The name of each test subject was also marked on his two uniforms. The identity of the fabrics was thus masked while the uniforms were clearly identified as to the test subjects wearing them to facilitate their issuance and inspection between periods of wear and dry cleanings.

The uniforms were issued and picked up on the following schedules

Garment	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
X	Issue	(.....Wear.....)		Pick up	(Clean and Inspect)	
Y	(Clean and Inspect)	Issue	(.....Wear....)		Pick up	

X and Y were interchanged at the halfway point. This schedule yields four days of wear per week, insures that the test uniforms are worn during days of duty, minimizes chances for wearing the wrong uniform and uses for the cleaning and inspection phases those days during which the officer normally wears civilian or informal clothing.

D. Serviceability Evaluation

Relative and Actual Suitability as Determined by Questionnaire. Although several series of questionnaires were utilized in this study, the most important was the final one given to the test subjects who wore uniforms at Fort Lee and Fort Bliss from June through September, 1951. This final questionnaire was the one designed to establish the relative and actual suitability of the uniforms.

The following basic criteria were used as guides in arriving at a decision:

1. Appearance as determined by:

   (a) Shape retention of the garments

      (1) Resistance to bagginess at knees, seat, and elbows

(2) Dimensional stability

(b) Crease retention

(c) Wrinkle resistance

(d) Resistance to discoloration when wet from perspiration and rain.

2. Comfort as determined:

(a) Under all ambient conditions for which the uniform is authorized, including hot days and cool nights.

(b) After resting from activity causing perspiration.

3. Soil Resistance, initially and after repeated wear and dry cleaning cycles, as characterized by:

(a) Resistance to normal soiling.

(b) Ease of dry cleaning, including effectiveness of removing dirt and stains, particularly from perspiration.

The test subjects were asked to express their preference for one of the two uniforms which they evaluated for each criterion. Quantitative values were assigned according to the intensity of their preference, i.e., 3-very much better, 2-moderately better, and 1-slightly better. A summary of the weighted scores was used to evaluate the fabrics. In addition to this criterion, the tests subjects were asked to state their preference, on the basis of which uniform was considered the better buy, assuming they were equal in price. Then they were asked to state whether they would consider each uniform acceptable or unacceptable.

Analysis of Worn Uniforms by Quartermaster Board Observers. Since wear resistance and dimensional stability could not be adequately determined by the test subjects, the worn uniforms were analyzed by trained Quartermaster Board observers during the wear test to determine the extent of wear failures and any changes in dimensions that the uniforms might have suffered. These observers recorded the location and type of fabric and seam failures, and also the number of weeks of wear and dry cleaning before the failures became evident. Cross-back width and back-waist length measurements were made on the coats at the beginning and at the end of the test at each site to determine whether the dimensional stability of the garments was satisfactory.

Discoloration by Rain and Perspiration. Although one of the criteria which was to have been used by the test subjects in evaluating their uniforms was resistance to discoloration when wet from perspiration and rain, many of the subjects failed to give information on this subject. Therefore, the Quartermaster Board conducted two separate detailed studies.

(a) Perspiration Phase - The Quartermaster Board determined the resistance of the fabrics to perspiration staining by requiring enlisted men dressed in test uniforms to run 50 paces, then walk 50 paces in a sun-exposed area until each uniform was soaked through at the back with sweat. Four uniforms of each fabric were used in this phase. The garments were examined and graded by an experienced observer-recorder using the three-point intensity scale. The uniforms were graded while wet from perspiration, when the perspiration was dry and, finally, after dry cleaning, to determine whether the perspiration stains were completely removed.

(b) Rain Phase - To evaluate the amount of staining after rain, four enlisted men were dressed in each of the seven experimental types of uniforms and marched three times through an artificial rainfall of one inch per hour on the Quartermaster Board Rain Course. The uniforms were graded as in the perspiration phase.

E. Supplementary Information

Preference Study of New Uniforms. In addition to the questionnaires administered to the wearers, other questionnaires were used to obtain supplementary information. One was an evaluation of the "on-the-rack" appeal of the uniforms to determine whether an initial reaction as to the suitability of a new uniform would differ from an overall evaluation of that uniform after actual wear. If differences existed between the initial reaction and the overall well-considered decision after wear, the results of this final questionnaire would be valuable as a guide to advise officers purchasing summer uniforms in the future.

Instructed vs. Non-Instructed Test Subjects. The test subjects who participated in the wear phase were divided into two equal groups. In order to determine whether they were biased in their judgment by being told what to look for in judging the suitability of a summer uniform, the first of these two groups was informed as to the criteria to be used as mentioned above, but the second group was given no such instructions. This division of the test subjects

into instructed and non-instructed groups was designed to test the validity of the criteria used and to determine whether additional reasons existed for preferring one type above another. The results of the test showed, however, that there was no difference between the opinions of the two groups.

Questionnaires Given During Progress of Test. Although the observations made in the following pages are mainly based on the results of the final questionnaire, two other questionnaires were also given, one after two days wear and the second half-way through the test. There was a double purpose in the utilization of these additional questionnaires, to determine (1) whether the same results would have been obtained with a shorter test, and (2) the extent of changes in response with increased experience. The test subjects were told that changes might be expected in their evaluation of the fabrics during the test to make it clear that the answer to one questionnaire could contradict that of a previous questionnaire if the subject's opinion of the relative merit of his uniforms had changed.

Panel of Judges. At the end of the wear test the test subjects' opinions were supplemented by the judgment of a panel of ten nonparticipating field grade officers who were selected by the Commanding General at each test site. The purpose of this panel was to judge the appearance of the garments at the termination of the normal wear phase prior to their final dry cleaning.

The judges were all briefed prior to the review and were furnished a set of typed instructions. Uniforms made of two of the fabrics were displayed at one time, and the judge recorded his individual opinion as to which was the better looking. Of the 84 test subjects at each station, 56 were selected for the final review, so that there would be eight men wearing each of the seven fabrics. This made it possible to parade eight men at a time. For instance, four men wearing "A" fabric uniforms marched on stage under a large sign reading "X". At the same time four more test subjects wearing "B" fabric uniforms marched on and stood under a sign reading "Y". This presentation by fours was done so that the judges would "average" the appearance of the uniforms and would not be biased by the looks, bearing, and physique of the four men wearing each fabric.

F. Discussion of Field Test Results

1. Relative and Actual Suitability of the Uniforms as Determined By Questionnaire.

Since it was determined (as will be shown later) that by the end of the serviceability test, there was no appreciable difference between the judgments of the test subjects at Fort Lee and those

at Fort Bliss, or between the instructed and uninstructed test subjects, the weighted scores of the 84 test subjects at each site were combined for each criterion.

Utilizing the statistical methodology for analyzing the "balanced incomplete block design," significant differences were determined among the total weighted scores for each criterion evaluated by the use of questionnaires. A discriminating method for ranking the fabrics on the basis of statistically significant differences was followed to enable the summer uniforms to be categorized into a Top, Middle, and Low group for each criterion, as was done in the laboratory evaluation.

Table XIII lists the total weighted scores for those criteria which could be reliably evaluated on the basis of the questionnaires and the consequent rating groups into which the summer uniforms were divided.

Appearance. Fabrics H (all-wool standard), F (mohair-viscose-acetate-nylon), and B (100% wool) looked best while Fabrics C and D (wool-rayon and wool-nylon) were poorest in appearance.

Comfort. Fabric C (wool-rayon) was the most comfortable while Fabric B (100% wool) was the most uncomfortable.

Soiling. Fabrics A and C (acetate-viscose and wool-rayon) exhibited poor soiling resistance, although it was indicated that normal soil from dirt, sweat, and rain was easily removed from these fabrics by normal dry cleaning procedures.

Actual Acceptability.* The all-wool standard, Fabric H, was determined to be significantly acceptable and Fabrics C and D (wool-rayon and wool-nylon) significantly unacceptable (95% probability) on the basis of the replies of the 48 men who wore each of the uniforms.

* The following procedure was followed to determine whether a fabric was significantly acceptable: First, the average number of "acceptable" votes given by all the subjects to all the fabrics was computed and found to be 29 (Fabrics A, B, C, D, E, F, and H, respectively, received 29, 33, 7, 21, 35, 35, and 44 "acceptable" votes for a total of 204, and an average of 29). Then the difference between the number of "acceptable" votes given each fabric and the number 29 was obtained to determine, using the Chi-square technique, the significance of that fabric's acceptability or unacceptability. For a fabric to be considered significantly acceptable, it would have to have received at least 36 "acceptable" votes. It would be considered significantly unacceptable if it received 22 "acceptable" votes or less.

TABLE XIII

OVERALL SUMMARY OF FIELD TEST EVALUATIONS ON SUMMER UNIFORMS

(Total of 168 Test Subjects - 48 Uniforms Each Type)

CRITERIA	SUMMER UNIFORMS							RATINGS			REMARKS
	A	B	C	D	E	F	H	TOP	MIDDLE	LOW	
	TOTAL WEIGHTED SCORE *										
APPEARANCE											
Crease Retention	48	79	7	28	53	82	86	HFB	EA	DC	
Bagginess	52	25	111	67	43	16	21	FHB	EAD	C	The larger numbers indicate the baggier and more wrinkled fabrics.
Wrinkling	63	23	120	75	49	26	17	HBF	EAD	C	
COMFORT											
Cooler	52	9	83	48	43	50	48	C	AFDHE	B	
More Comfortable When Rest After Perspiring	47	18	58	31	45	47	49	CHFAE	D	B	
SOILING	50	34	61	39	36	27	26	HFBED		AC	
ACCEPTABILITY**	29	33	7	21	35	35	44	H		CD	
BEST BUY	42	64	9	28	61	76	95	H	FBE	ADC	

* Figures shown in the body of the table represent the summary of the weighted scores of the test subjects preference by each criteria for one of the 2 uniforms which they evaluated. The following values were assigned according to the intensity of their preference: 3-very much better 2-moderately better and 1-slightly better. Results of Fort Lee and Fort Bliss were combined.

** Number shown as being acceptable represents total number of officers out of a possible 48 who stated that uniform was acceptable. At least 36 had to state it to be significantly acceptable and less than 22 to be unacceptable.

Best Buy. After extended wear and careful weighing of all of the evidence by the test subjects, assuming all fabrics were equal in price, **Fabric H, the all-wool standard, was considered the best buy and Fabrics A (acetate-viscose), D (wool-nylon), and C (wool-rayon)** as the poorest.

Relative Importance of Each Criterion. Since the relative rankings for appearance are more closely related to the overall Best-Buy rankings than those of any other criterion it might be concluded that this characteristic is most important for determining the overall suitability of summer uniforms. This is brought out in the case of Fabric C which, although deemed the most comfortable, had the poorest appearance rating and was considered unacceptable and the poorest buy. In addition, Fabric D, which had a poor appearance, was deemed unacceptable and a poor buy, even though it was satisfactory for the other criteria.

In Figure 1 are plotted the scores received by each fabric on the basis of questionnaire answers as to which was the best buy, which would be considered acceptable per se for a summer uniform regardless of its relative evaluation, which was coolest, and which had best crease retention.

2. Wear Resistance

A careful evaluation of fabric failures was made by the test teams. The uniforms worn at Fort Bliss showed considerably more wear than those at Fort Lee which might possibly be due to the abrasive action of the fine dust at the former site.

Table XIV is based on 32 uniforms* of each fabric worn at Fort Bliss. The number showing abrasive wear and the locations of the wear are given in the table. Fabrics A, C, and F showed the greatest sensitivity to abrasion. In addition there was a large number of complaints that the Fabric C trousers wore through at the seat. The observer recorders were of the opinion that Fabrics A and C were considerably less durable than any of the others. Only a negligible number of seam failures were reported.

3. Dimensional Stability

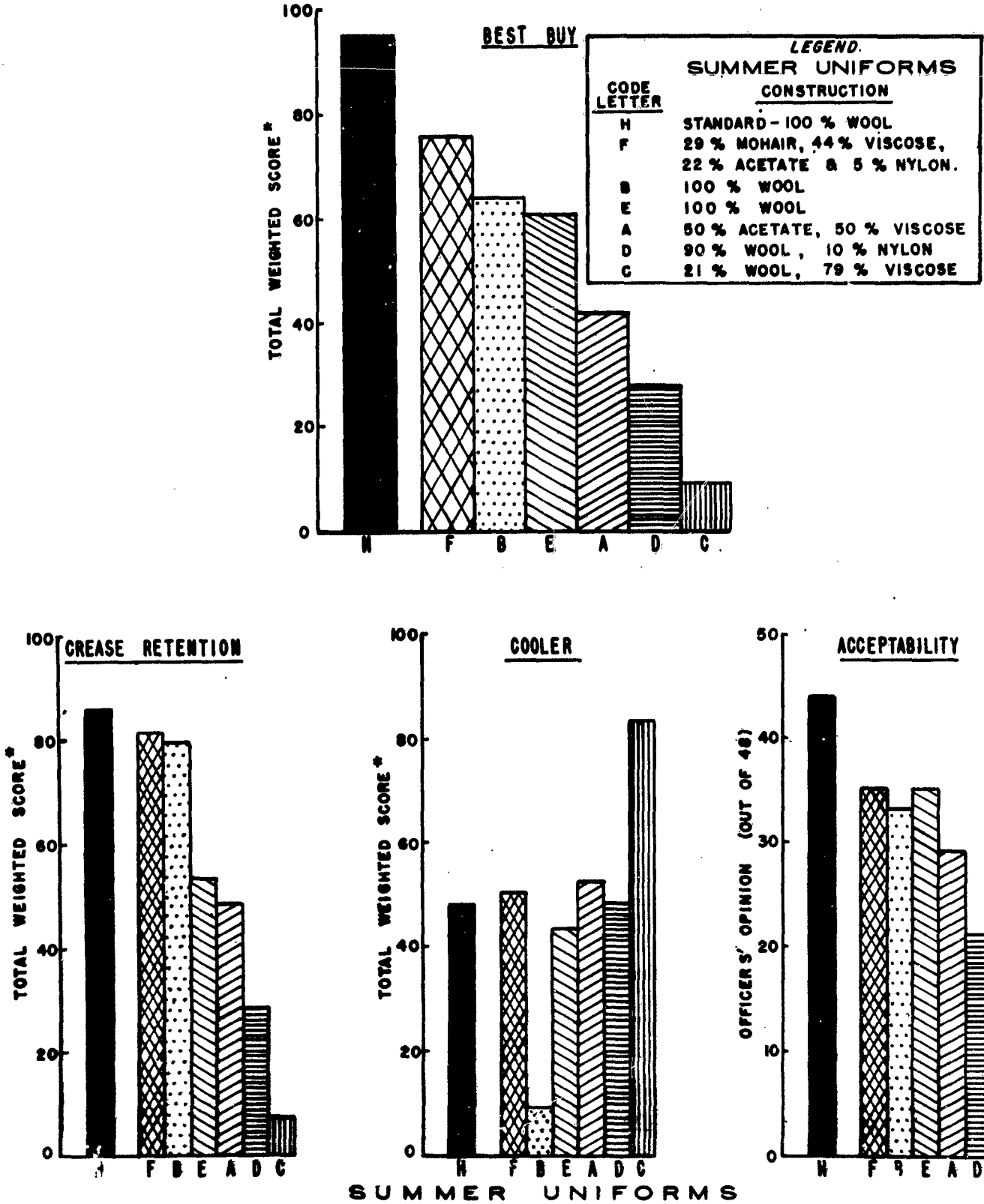
Cross-back width and back-waist length measurements were made on the coats worn at Fort Lee and at Fort Bliss both at the beginning

* The 32 uniforms consisted of 24 tested in accordance with the test plan, plus 8 additional uniforms worn by officers at the test site.

FIG. 1

SUITABILITY OF SUMMER UNIFORMS

(TEST SUBJECTS EVALUATION IN FIELD TEST)



*WEIGHTED ACCORDING TO THE INTENSITY OF THEIR PREFERENCE.

of the test and at the end. The average shrinkage for each of the fabric types never exceeded 1/2 inch.

TABLE XIV

Wear Resistance of Summer Uniforms
(32 Uniforms of Each Type)

LOCATION	SUMMER UNIFORMS						
	A	B	C	D	E	F	H
Small Holes at Sleeve Crease	31	1	32	0	3	28	3
Miscellaneous Areas	17	8	24	6	8	11	6
Total Number of Uniforms*	31	9	32	6	11	31	8

* It should be realized that wear may occur at both locations on one uniform.

4. Discoloration From Rain and Perspiration

Perspiration Phase - In the special Quartermaster Board test in which the uniforms were worn in a sun-exposed area, all the uniforms became soaked with perspiration after exercise by the test subjects. After the uniforms had dried, only a negligible amount of staining remained, and this was completely removed by dry cleaning.

Rain Phase - Examination of the uniforms after they were worn three times in an artificial rainfall failed to reveal any rain spotting, either after they had dried or after they were dry cleaned.

5. Supplementary Studies

Effect of Differences in Climate. Table XV lists both the total weighted score and its absolute arithmetic rank for each fabric based on the responses of the test subjects as to which of

TABLE XV

CONSISTENCY BETWEEN FT. LEE AND FT. BLISS IN EVALUATION OF SUMMER UNIFORMS

(The higher the rank* number, the better the fabric)

STAGE	SUMMER UNIFORMS A Amt.	A Rank	B Amt.	B Rank	C Amt.	C Rank	D Amt.	D Rank	E Amt.	E Rank	F Amt.	F Rank	H Amt.	H Rank
BEST BUY														
TOTAL WEIGHTED SCORE**														
PRE-TEST "On the Rack"														
Ft. Lee	35	6	14	2	15	3	5	1	33	5	28	4	41	7
Ft. Bliss	39	6	33	5	20	4	6	1	15	2	18	3	40	7
FIRST QUESTIONNAIRE***														
Ft. Lee	7	1.5	14	5	7	1.5	11	3	12	4	23	7	19	6
Ft. Bliss	9	3	2	1	8	2	16	5	12	4	17	6	23	7
FINAL QUESTIONNAIRE														
Ft. Lee	21	3	40	5	5	1	13	2	27	4	46	6.5	46	6.5
Ft. Bliss	21	3	24	4	4	1	15	2	34	6	30	5	49	7
ACCEPTABILITY														
(Number Acceptable Out of a Possible 24 Uniforms)														
PRE-TEST "On the Rack"														
Ft. Lee	21	5.5	17	3	13	1.5	13	1.5	19	4	21	5.5	24	7
Ft. Bliss	22	5.5	22	5.5	13	1	14	2	21	4	18	3	23	7
FINAL QUESTIONNAIRE														
Ft. Lee	16	3	18	5	4	1	9	2	17	4	21	6.5	21	6.5
Ft. Bliss	13	3	15	5	3	1	12	2	18	6	14	4	23	7

* Fabrics ranked arithmetically.

** Weighted score of test subjects preference for one of two uniforms evaluated and weighted according to the intensity of their preference.

*** Based only upon the 42 instructed test subjects at each site.

the fabrics they wore was considered a better buy and more acceptable for the two different climatic conditions (warm-humid, Fort Lee; hot-dry, Fort Bliss). This is done for the (a) pretest "on-the-rack" evaluation, (b) first questionnaire and (c) final questionnaire. There is a difference between the rankings obtained at the two test sites for Fabrics B and E on the pretest, and for B on the first questionnaire. On the final questionnaire, the fabrics are ranked approximately the same at both sites for best-buy and acceptability. Thus we are not limited in our conclusions as to the suitability of the fabrics under differing climatic conditions.

Preference Study of New Uniforms. Table XVI compares the evaluations of the initial reactions of a group of officers to the new uniforms displayed on the rack. These officers, who were not scheduled for participation in the normal wear phase, were first shown two different uniforms. The experimental design of the overall test plan was followed. Each officer was requested to indicate which uniform he considered the better buy, price being equal. Each test subject then stated whether he considered the chosen uniform to be a much better, a moderately better, or a slightly better buy. The answers were weighted by factors of 3, 2, and 1, respectively. The officers were also questioned as to the acceptability or nonacceptability of the uniforms. These results were then compared with those obtained by the test subjects participating in the normal wear phase.

There is a marked disparity between the initial reaction and overall judgment on Fabrics A and F, (acetate-viscose and mohair-viscose-acetate-nylon) and Fabric C (wool-rayon). Fabric F had a harsh feel and Fabric A a bright, very attractive initial appearance. In the pretest Fabric A was rated as the best buy and Fabric F in the low-medium category, but after extended serviceability wear the rankings of the two fabrics were reversed. In addition, Fabric C was not rated as poor on the pretest. All this clearly demonstrates that "on-the-rack" judgment can prove to be quite erroneous.

Instructed vs. Non-Instructed Test Subjects. The non-instructed test subjects were not asked to state their preferences until the end of the test. The instructed subjects were given three questionnaires during the course of the test and were told what characteristics to consider in their evaluation. At the end of the test the non-instructed subjects were asked which of the two uniforms they had worn they considered the better buy. Then both groups were given the same final questionnaire which included (for the benefit of the the instructed subjects) a question as to which was the better buy. Table XVII lists the total scores and their arithmetic rank for the instructed and non-instructed test subjects as far as better buy

TABLE XVI

COMPARISON OF INITIAL REACTIONS (PRETEST) WITH EXTENDED JUDGMENTS (END OF TEST)

(The higher the rank* number, the better the fabric)

STAGE**	SUMMER UNIFORMS A Amount	A Rank	B Amount	B Rank	C Amount	C Rank	D Amount	D Rank	E Amount	E Rank	F Amount	F Rank	H Amount	H Rank	Overall Ratings Top	Middle	Low
BEST BUY																	
TOTAL WEIGHTED SCORE ***																	
Pretest (Initial Reaction)	74	6.0	47	4.0	35	2.0	11	1.0	48	5.0	46	3.0	81	7.0	HA	BEFC	D
Final Questionnaire (End of Test)	42	3.0	64	5.0	9	1.0	28	2.0	61	4.0	76	6.0	95	7.0	H	FBE	ADC
ACCEPTABILITY																	
(Number Acceptable Out of a Possible 48)																	
Pretest (Initial Reaction)	43	6.0	39	3.5	26	1.0	27	2.0	40	5.0	39	3.5	47	7.0	HA		DC
Final Questionnaire (End of Test)	29	3.0	33	4.0	7	1.0	21	2.0	35	5.5	35	5.5	44	7.0	H		CD

* Fabrics ranked arithmetically.
** Two groups of 168 officers participated; one group in pretest and the other group over extended test.
*** Weighted score of test subjects preference for one of two uniforms evaluated and weighted according to the intensity of their preference.

TABLE XVII

COMPARISON OF JUDGMENTS OF NON-INSTRUCTED AND INSTRUCTED TEST SUBJECTS

(The higher the rank* number, the better the fabric)

STAGE	SUMMER UNIFORMS A Amount	A Rank	B Amount	B Rank	C Amount	C Rank	D Amount	D Rank	E Amount	E Rank	F Amount	F Rank	H Amount	H Rank
BEST BUY														
TOTAL WEIGHTED SCORE**														
PRETEST***														
Non-Instructed	38	6.0	27	5.0	17	2.0	6	1.0	21	4.0	20	3.0	41	7.0
Instructed	36	6.0	20	3.0	18	2.0	5	1.0	27	5.0	26	4.0	40	7.0
END OF TEST														
Non-Instructed	19	3.0	31	5.0	4	1.0	15	2.0	26	4.0	42	6.0	52	7.0
Instructed	23	3.0	33	4.0	5	1.0	13	2.0	35	6.0	34	5.0	43	7.0
ACCEPTABILITY														
(Number Acceptable Out of a Possible 24 Uniforms)														
PRETEST***														
Non-Instructed	22	6.0	19	3.0	14	1.0	18	2.0	21	4.5	21	4.5	24	7.0
Instructed	21	6.0	20	5.0	12	2.0	9	1.0	19	4.0	18	3.0	23	7.0
END OF TEST														
Non-Instructed	15	4.0	15	4.0	4	1.0	13	2.0	15	4.0	18	6.0	22	7.0
Instructed	14	3.0	18	5.0	3	1.0	8	2.0	20	6.0	17	4.0	22	7.0

* Fabrics ranked arithmetically.
** Weighted score of test subjects preference for one of two uniforms evaluated and weighted according to the intensity of their preference.
*** Two groups of officers participated. One group in a pretest, and the other group in an extended test.

and acceptability are concerned. An analogous situation existed for the officers participating in thepretest. It is demonstrated that no difference exists between the instructed and non-instructed groups in their initial reaction on the pretest, or in their judgment after extended wear.

The above illustrates that the test subjects were unbiased and that the results obtained for the suitability of the fabrics are valid.

Questionnaires Given During Progress of Test. Table XVIII compares the opinions as to which uniform is a better buy and more acceptable at the beginning, midpoint and end of the test. Fabric C (wool-rayon) is always the poorest regardless of the time of evaluation. Although Fabric D (wool-nylon) showed its inferiority at the midway mark, the superiority of the H (all-wool standard) and F (mohair-viscose-acetate-nylon) fabrics is not clearly revealed until the last questionnaire. Fabrics D and A (wool-nylon and acetate-viscose) get relatively poorer with extended wear. In addition, a good discrimination among the fabrics is not obtained until the final questionnaire results are considered. Consequently the test time could not have been shortened.

TABLE XVIII

Evaluation of Preferences as to Best Buy and Acceptability on Successive Questionnaires

QUESTIONNAIRE*	BEST BUY			ACCEPTABILITY	
	Rating**			Signif.	Signif.
	Top	Middle	Low	Acceptable	Unacceptable
1st (after 2 days)		HFDEABC		H	C
2nd (Midpoint)		EHFHADC		E	CD
Final	H	FEE	ADC	H	CD

* First and second questionnaire based upon the 42 instructed test subjects at each site. The final includes both instructed and non-instructed test subjects.

** Based upon the weighted score of test subjects' preference for one of two uniforms evaluated and weighted according to the intensity of their preference.

Panel Judgment. Table XIX lists the evaluation of the worn garments by the panel of ten judges, as to which fabrics have a better appearance and which are more acceptable. There is a marked similarity between the results at Fort Lee and at Fort Bliss indicating the reliability of the judges' opinions. Fabrics A (acetate-viscose), E (100% wool), F (mohair-viscose-acetate-nylon), and H (all-wool standard) are judged as having the best appearance and greatest acceptability and Fabrics C and D (wool-rayon and wool-nylon) the poorest for the two criteria. There was thus good agreement between the panel judgments and the considered opinions of the test subjects as to the appearance and acceptability of the summer uniforms.

IV. COMPARISION OF LABORATORY AND FIELD OBSERVATIONS

An important phase of this study was the determination of which laboratory tests best predicted serviceability under actual conditions of wear and how well the overall laboratory ratings and the field test ratings compared. The criterion used for the correlation study was Spearman's Rank Correlation coefficient for which the closer the coefficient is to ± 1, the greater is the correlation. Table XX lists these correlation coefficients.

TABLE XX

Correlation Between Laboratory and Field Test Evaluations of the Summer Uniforms

	Appearance		
Laboratory Test*	Crease Retention	Bagginess	Comfort
CREASE RECOVERY	Spearman's Rank Correlation Coefficients		
Warp	.39	.55	
Filling	.4	.14	
COVER INDEX	.79	.70	
WEIGHT	.88	.76	.60
STIFFNESS			
Warp	.61	.53	.76
Filling	.90	.83	.71
AIR PERMEABILITY			.79

* As based upon combined rank of Initial and after 10 Dry Cleanings.

TABLE XIX

EVALUATION OF SUMMER UNIFORMS BY PANEL OF 10 JUDGES AT EACH SITE

SITE	SUMMER UNIFORMS													
	A		B		C		D		E		F		H	
	Amt.	Rank	Amt.	Rank	Amt.	Rank	Amt.	Rank	Amt.	Rank	Amt.	Rank	Amt.	Rank
	APPEARANCE													
	TOTAL WEIGHTED SCORE*													
Ft. Lee	71	5	38	3	1	1	33	2	68	4	78	7	77	6
Ft. Bliss	82	7	58	3	5	1	9	2	81	6	70	5	61	4
Combined	153		96		6		42		149		148		138	
	ACCEPTABILITY**													
Ft. Lee	48	4.5	44	3	10	1	36	2	54	6	48	4.5	57	7
Ft. Bliss	54	5.5	52	3	7	1	28	2	53	4	54	5.5	50	7
Combined	102		96		17		64		107		102		107	
	GROUP RATING (T-Top, M-Medium, L-Low)													
Appearance	T		M		L		L		T		T		T	
Acceptability	T		T		L		L		T		T		T	

* Cumulative weighted score of test panel's preference for one of two uniforms evaluated and weighted according to the intensity of its preference.

** Cumulative number of times rated acceptable out of a possible 60.

As will be noted in the tables, if a single laboratory test were to be used to predict appearance and comfort under conditions of summer use, these results would indicate that weight and stiffness in the filling direction would be the best. However, it should be noted that the use of a single test to predict any consumer characteristics of fabrics is hazardous without previous knowledge of the behavior of similar type fabrics and the usage intended.

The effect of weight on appearance and comfort is shown in Table XXI. This table provides estimates of what the scores of all the summer uniforms would have been for crease retention and coolness if their weight had been equal to 10.7 oz, that of the standard, Fabric H. The regression relationship between weight and these criteria was the basis of these estimates. The most significant change brought about by this estimation is in Fabric D, (wool-nylon) whose appearance rating becomes one of the best.

Table XXII shows that with few exceptions, a good agreement exists between the summer uniform rankings in the field and the overall laboratory evaluation of the fabrics. Thus laboratory tests can be considered quite useful in predicting serviceability and should be used extensively before large-scale wear tests are conducted.

V. CONCLUSIONS

1. Fabric H, the standard 100% wool tropical worsted uniform fabric (JAN-C-391, August, 1946) was shown by both laboratory and field evaluations to be the most suitable fabric for a summer uniform.

2. Fabrics C (79% Viscose-21% Wool) and D (10% Nylon-90% Wool) were shown by both laboratory and field evaluations to be unacceptable and least suitable for summer uniforms.

3. Of those fabrics not rated as unacceptable, Fabric A (50% Viscose-50% Acetate) would be the least suitable since it was judged to be a poor buy by the test subjects. It also has poor wear and soiling resistance properties.

4. Fabrics E (100% wool), F (29% mohair-44% viscose-22% acetate-5% nylon), and B (100% wool, tight weave) were judged equally suitable for summer uniforms, although Fabric B was very uncomfortable, and Fabric F, and to some extent Fabric E, exhibited poor wear resistance.

TABLE XXI

EFFECT OF WEIGHT ON THE APPEARANCE AND COMFORT EVALUATION OF THE SUMMER UNIFORMS

(The higher the rank* number, the better the fabric)

Summer Uniform	Fabric Weight (oz/lin.yd. 56" width)	Crease Retention				Coolness			
		Actual		Estimated (If wt. were 10.7oz.)		Actual		Estimated (If wt. were 10.7oz.)	
		Amount	Rank	Amount	Rank	Amount	Rank	Amount	Rank
		TOTAL WEIGHTED SCORE** (Field Test)							
A	10.0	48	3	64	2	52	6	45	5
B	10.7	79	5	79	3	9	1	9	1
C	8.5	7	1	57	1	83	7	71	7
D	7.8	28	2	94	6	48	3.5	19	2
E	9.0	53	4	92	5	43	2	26	3
F	10.0	82	6	98	7	50	5	43	4
H	10.7	86	7	86	4	48	3.5	48	6

* Fabrics ranked arithmetically.

** Weighted score of test subjects preference for one of two uniforms evaluated and weighted according to intensity of preference.

TABLE XXII

COMPARISON BETWEEN OVERALL LABORATORY AND FIELD TEST EVALUATIONS OF SUMMER UNIFORM FABRICS FOR EACH CRITERION

(L = Low Group, M = Medium Group, T = Top Group)

CRITERIA	SUMMER UNIFORM FABRICS						
	A	B	C	D	E	F	H
APPEARANCE							
Laboratory *	M	T	L	L	M	M	T
Field Test	M	T	L	L	M	T	T
COMFORT							
Laboratory *	M	L	T	T	M	M	L
Field Test	M	L	T	M	M	M	M
WEAR RESISTANCE							
Laboratory *	L	T	L	T	L	T	T
Field Test **	L	T	L	T	T	L	T

* Combined initial and after 10 dry cleanings evaluation.
** As evaluated by the test team and not by wearers.

5. In the field trials significant differences were found in wear resistance among the fabrics, with the all-wool samples performing well in this respect and the samples containing rayon performing poorly.

6. Fabric A (50% viscose-50% acetate) and Fabric D (90% wool-10% nylon) became more unsuitable with extended wear.

7. Appearance would be the most important single criterion for evaluating the suitability of a fabric for a summer uniform.

8. The panel of field grade officers confirmed the evaluations of the test subjects as to the appearance of the worn garments.

9. With few exceptions, there was a fairly good agreement between the overall laboratory and field test evaluations of the summer uniforms as far as appearance, comfort, and wear resistance were concerned.

10. For the fabrics evaluated, weight and stiffness in the filling direction would be the two most important properties for predicting the ultimate consumer characteristics of appearance and comfort.

APPENDIX A

CALCULATIONS OF COVER INDEX FOR ALL FABRICS ("AS RECEIVED")

	FABRICS						
	A	B	C	D	E	F	H
1. Yarn count (equivalent)							
Warp	18.4	15.6	22.4	21.3	19.4	14.8	17.4
Filling	18.7	15.5	21.2	25.9	21.7	16.1	16.6
2. Spec. gravity of fiber blends (weighted average)							
Warp	1.40	1.30	1.46	1.28	1.30	1.40	1.30
Filling	1.40	1.30	1.46	1.28	1.30	1.33	1.30
3. Adjusted yarn count (equivalent)							
Warp	19.80	15.60	25.20	21.20	19.40	15.90	17.40
Filling	20.20	15.50	23.80	25.80	21.70	16.50	16.60
4. Avg. adjusted yarn count (equivalent)	20.00	15.55	24.50	23.50	20.34	16.20	17.00
5. Texture							
Ends/in.	56.00	50.00	58.00	54.00	53.00	49.00	56.00
Picks/in.	49.00	44.00	47.00	49.00	50.00	40.00	46.00
Total	105.00	94.00	105.00	103.00	103.00	89.00	102.00
6. $\sqrt{\text{Average adjusted yarn count}}$	4.47	3.94	4.95	4.85	4.51	4.03	4.12
7. Cover index $= \frac{\text{ends/in. + picks/in.}}{\sqrt{\text{avg. adj. yarn count}}}$	23.4	23.8	21.4	21.3	22.7	22.1	24.8

APPENDIX B

DRY CLEANING

The uniforms shall be cleaned in accordance with the following procedure, this process being one which is fairly reproducible among plants and which may be expected to be encountered in the dry cleaning industry.

(1) Dry cleaning solvent

The dry cleaning solvent used shall be Stoddard solvent. Most dry cleaning is done in this solvent.

(2) Dry cleaning washers

Dry cleaning washers shall be metal cylinder, direct motor driven, and shall turn at the speed intended by the manufacturer.

(3) Filters

Dry cleaning washers shall be connected to a filter which can furnish a flow rate of at least 30 theoretical changes in washer per hour.

(4) Loading of washers

All washers shall be filled one-third of the inside diameter with solvent before garments are introduced. Each load shall consist entirely of test garments. The following table gives typical washer sizes, limits on the size of the load for each and the minimum size filter which must be used in connection with each washer:

Washer Cylinder Size (inches)	Maximum and Minimum Limit for Size of Load (pounds)	Minimum Size Filter (Gallons per hour)
30 x 48	47 - 57	2,000
36 x 54	70 - 90	3,000
36 x 64	90 - 102	3,600
42 x 54	100 - 120	4,200
42 x 64	120 - 136	4,800
42 x 84	155 - 173	6,000
54 x 70	200 - 235	8,000

(5) Soap or detergent

A dry cleaning soap or detergent shall be used. The amount shall be in accordance with the manufacturer's directions for cleaning wool garments. An emulsion of water may be incorporated with the soap or detergent according to the discretion of the dry cleaner, but the amount of water added to the washer (including that in the original soap) shall not exceed 1/2 oz of water per pound of load.

(6) Cleaning cycle

After the washer has been properly loaded it shall be started with the filter circulation, the soap or detergent added and the washer run 15 minutes. The filter circulation shall then be started and the washer run another 20 minutes.

(7) Extraction

Excess solvent shall be removed from the garments in a centrifugal extractor in a conventional manner. In the case of wool materials, not more than 15% by weight of Stoddard solvent should be left in the fabric after extraction.

(8) Drying

Drying should be done in a tumbler loaded in accordance with the manufacturer's directions (a 40 pound load for a 30 x 36" open end tumbler). A thermometer or other temperature indicating device shall be inserted in the exhaust stack of the tumbler. During drying the air shall not be under 155°F. and not over 170°F. No cold air shall be used at the start of the drying, the process starting immediately with full heat. Tumbling shall continue for 20 minutes or until the garments are dry, whichever is the longer.

(9) Pressing

It is difficult to specify a method of pressing which will be satisfactory for all the fabrics under test. A grid head press with steam pressure from 60 - 75 p.s.i. is suggested.

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